04-108

AGREEMENT
BETWEEN
THE NUCLEAR REGULATORY COMMISSION
OF THE UNITED STATES OF AMERICA
AND
THE HUNGARIAN ATOMIC ENERGY AUTHORITY
IN
THE AREA OF PROBABILISTIC RISK ASSESSMENT RESEARCH

The United States Nuclear Regulatory Commission (USNRC) and the Hungarian Atomic Energy Authority (HAEA), the two together hereinafter referred to as "the Parties";

Considering that the Parties:

1. Have a mutual interest in cooperation in the field of nuclear safety research with the objective of improving and thus ensuring the safety of civilian nuclear installations on an international basis;

2. Recognize a need to equitably share both the resources resulting from this research and the effort required to develop those resources;

3. Have an interest in cooperating in the area of reliability, risk assessment, and other related areas of nuclear safety research;

4. Recognize the Arrangement between the United States Nuclear Regulatory Commission and the Hungarian National Atomic Energy Commission (HNAEC, the predecessor agency of the HAEA) for the Exchange of Technical Information and Cooperation in Nuclear Safety Matters, signed on November 6, 2001, hereinafter referred to as the "Arrangement"; and

5. Have been cooperating in the area of probabilistic risk assessment research since August 18, 1998, and this Agreement is a continuation of such cooperation;

The Parties HAVE AGREED as follows:

ARTICLE I - PROGRAM COOPERATION

The Parties, in accordance with the provisions of this Agreement and subject to applicable laws and regulations in force in their respective countries, will continue a program for cooperative research in probabilistic risk assessment sponsored by the USNRC as well as those sponsored by the HAEA.

ARTICLE II - FORMS OF COOPERATION

Cooperation between the Parties may take the following forms:

A. Exchange of information in the form of technical reports, experimental data, correspondence, newsletters, visits, joint meetings, and such other means as the Parties agree.

B. Temporary assignment of personnel of one Party or of its contractors to the laboratory or facilities owned by the other Party or in which it sponsors research; each assignment shall be considered on a case-by-case basis and may be the subject of a separate attachment-of-staff arrangement between appropriate representatives of the recipient and assigning organizations.

C. Execution of joint programs and projects, including those involving a division of activities between the Parties; each joint program and project shall be considered on a case-by-case basis and may be the subject of a separate agreement between the Parties, as appropriate.

D. Use by one Party of facilities that are owned by the other Party or in which research is being sponsored by the other Party; such use of facilities may be the subject of separate agreements between the relevant entities and may be subject to commercial terms and conditions.

E. If either Party wishes to visit, assign personnel, or use the facilities owned or operated by entities other than the Parties to this Agreement, the Parties recognize that prior approval of such entities will, in general, be required regarding terms upon which such visit, assignment, or use shall be made.

F. Any other form agreed between the Parties.

ARTICLE III - SCOPE OF AGREEMENT

Subject to the availability of appropriated funds, the USNRC and the HAEA will cooperate in the areas of probabilistic risk assessment research outlined in Article I. The specific details of this cooperation are outlined in Appendix Parts I and II, which are integral parts of this Agreement.

ARTICLE IV - ADMINISTRATION OF THE AGREEMENT

A. The USNRC and the HAEA will each designate one representative to coordinate and determine the detailed implementation of this Agreement. These representatives may, at their discretion, delegate this responsibility to the appropriate technical staff with respect to a given issue. The single designated representative will be referred to as an Administrator of this Agreement.

B. Information on matters related to organization, budget, personnel, or management may be restricted under this Agreement.

C. The USNRC and the HAEA will endeavor to select technical personnel for assignment to these cooperative programs who can contribute positively to the programs. USNRC and HAEA personnel assigned for extended periods will be considered visiting scientists (nonsalaried) within the programs in this Agreement and will be expected to participate in the conduct of the analyses and/or experiments as necessary.

D. Each Party to this Agreement will have access to all pertinent reports written by its partner's technical personnel assigned to the respective programs that derive from its participation in those programs.

E. Travel costs, living expenses, and salaries will be borne by the Parties who incurred them unless specified otherwise.

ARTICLE V - EXCHANGE AND USE OF INFORMATION AND INTELLECTUAL PROPERTY

A. General

The Parties support the widest possible dissemination of information provided or exchanged under this Agreement, subject both to the need to protect proprietary or other confidential or privileged information as may be exchanged hereunder, and to the provisions of the Intellectual Property Addendum, which is an integral part of this Agreement.

B. Definitions (As used in this Agreement)

1. The term "information" means nuclear energy-related regulatory, safety, safeguards, waste management, scientific, or technical data, including information on results or methods of assessment, research, and any other knowledge intended to be provided or exchanged under this Agreement.

2. The term "proprietary information" means information created or made available under this Agreement which contains trade secrets or other privileged or confidential commercial information (such that the person having the information may derive an economic benefit from it or may have a competitive advantage over those who do not have it), and may only include information which:

   a. has been held in confidence by its owner;

   b. is of a type which is customarily held in confidence by its owner;

   c. has not been transmitted by the owner to other entities (including the receiving Party) except on the basis that it be held in confidence;

   d. is not otherwise available to the receiving Party from another source without restriction on its further dissemination; and

   e. is not already in the possession of the receiving Party.

3. The term "other confidential or privileged information" means information, other than "proprietary information," which is protected from public disclosure under the laws and regulations of the country of the Party providing the information and which has been transmitted and received in confidence.

C. Marking Procedures for Documentary Proprietary Information

A Party receiving documentary proprietary information pursuant to this Agreement shall respect the privileged nature thereof, provided such proprietary information is clearly marked with the following (or substantially similar) restrictive legend:

> "This document contains proprietary information furnished in confidence under an Agreement dated _______ between the United States Nuclear Regulatory Commission and the Hungarian Atomic Energy Authority and shall not be disseminated outside these organizations, their consultants, contractors, and licensees, and concerned departments and agencies of the Government of the United States and the Government of Hungary without the prior approval of (name of transmitting Party). This notice shall be marked on any reproduction hereof, in whole or in part. These limitations shall automatically terminate when this information is disclosed by the owner without restriction."

This restrictive legend shall be respected by the receiving Party and proprietary information bearing this legend shall not be used for commercial purposes, made public, or disseminated in any manner unspecified by or contrary to the terms of this Agreement without the consent of the transmitting Party.

D. Dissemination of Documentary Proprietary Information

1. In general, proprietary information received under this Agreement may be freely disseminated by the receiving Party without prior consent to persons within or employed by the receiving Party, and to concerned Government departments and Government agencies in the country of the receiving Party.

2. In addition, proprietary information may be disseminated without prior consent:

   a. to prime or subcontractors or consultants of the receiving Party located within the geographical limits of that Party's State, for use only within the scope of work of their contracts with the receiving Party in work relating to the subject matter of the proprietary information;

   b. to domestic organizations permitted or licensed by the receiving Party to construct or operate nuclear production or utilization facilities, or to use nuclear materials and radiation sources, provided that such proprietary information is used only within the terms of the permit or license; and

   c. to domestic contractors of organizations identified in D.2.b., above, for use only in work within the scope of the permit or license granted to such organizations;

Provided that any dissemination of proprietary information under D.2.a., b., and c., above, shall be on an as-needed, case-by-case basis, shall be pursuant to an agreement of confidentiality, and shall be marked with a restrictive legend substantially similar to that appearing in C. above.

3. With the prior written consent of the Party furnishing proprietary information under this Agreement, the receiving Party may disseminate such proprietary information more widely than otherwise permitted in subsections 1. and 2. The Parties shall cooperate in developing procedures for requesting and obtaining approval for such wider dissemination, and each Party will grant such approval to the extent permitted by its national policies, regulations, and laws.

E. Marking Procedures for Other Confidential or Privileged Information of a Documentary Nature

A Party receiving under this Agreement other confidential or privileged information shall respect its confidential nature, provided such information is clearly marked so as to indicate its confidential or privileged nature and is accompanied by a statement indicating:

1. that the information is protected from public disclosure by the Government of the transmitting Party; and

2. that the information is transmitted under the condition that it be maintained in confidence.

F. Dissemination of Other Confidential or Privileged Information of a Documentary Nature

Other confidential or privileged information may be disseminated in the same manner as that set forth in paragraph D., Dissemination of Documentary Proprietary Information.

G. Non-Documentary Proprietary or Other Confidential or Privileged Information

Non-documentary proprietary or other confidential or privileged information provided in seminars and other meetings arranged under this Agreement, or information arising from the attachments of staff, use of facilities, or joint projects, shall be treated by the Parties according to the principles specified for documentary information in this Agreement; provided, however, that the Party communicating such proprietary or other confidential or privileged information has placed the recipient on notice as to the character of the information communicated.

H. Consultation

If, for any reason, one of the Parties becomes aware that it will be, or may reasonably be expected to become, unable to meet the non-dissemination provisions of this Agreement, it shall immediately inform the other Party. The Parties shall thereafter consult to define an appropriate course of action.

I. Other Considerations

1. Nothing contained in this Agreement shall preclude a Party from using or disseminating information received without restriction by a Party from sources outside of this Agreement.

2. All USNRC computer codes disseminated under this Agreement are to be considered privileged information unless otherwise noted, are protected as such by the USNRC, and shall be treated likewise by the HAEA. They are, in particular, subject to all of the provisions of this Article including the requirement for an agreement of confidentiality (Article V) noted above prior to dissemination, with the exception that they need not be marked with the restrictive designation. The codes are subject to this protection in both object and source forms and as recorded in any media.

3. The USNRC codes and other related analytical techniques covered under this Agreement, and any improvements, modifications or updates to such codes or techniques, are for the purpose of reactor and plant systems safety research and licensing and will not be used for commercial purposes, or for other benefits not related to the study of reactor safety without the prior consent of the USNRC. The USNRC codes and other related analytical techniques will not be advertised directly or by implication to obtain contracts related to the construction or servicing of nuclear facilities, nor will advertising imply that the USNRC has endorsed any particular analyses or techniques.

4. All reports published within the scope of this Agreement and all meetings held will be in English.

ARTICLE VI - FINANCIAL CONSIDERATIONS

A. All costs arising from implementation of this Agreement will be borne by the Party that incurs them, except when specifically agreed to otherwise. It is understood that the ability of the Parties to carry out their obligations is subject to the availability of funds. It is also understood that the terms herein agreed to represent feasible commitments according to the best understanding regarding resources and costs of the Parties at the time of signature.

B. HAEA will not make cash payments under the Cooperative Probabilistic Risk Assessment Program and will only make in-kind contributions to the USNRC programs in the area of probabilistic risk assessment as described in the Appendix, Part II.

ARTICLE VII - DISPUTES AND WARRANTY OF INFORMATION

A. Information furnished by one Party to the other under this Agreement will be accurate to the best knowledge and belief of the Party supplying the information. However, the application or use of any information exchanged or transferred between the Parties under this Agreement will be the responsibility of the Party receiving the information, and the Transmitting Party does not warrant the suitability of the information for any particular use or application.

B. The USNRC makes no warranties, whatsoever, for the ability or suitability of any USNRC code or other analytical technique to perform in any particular manner for any particular purpose, or to accomplish any particular task. The USNRC accepts no liability for damages of any type that may result from the use of its codes or other analytical techniques provided under this Agreement.

C. Cooperation under this Agreement will be in accordance with the laws and regulations of the respective countries. Any dispute or questions between the Parties concerning the interpretation or application of this Agreement arising during its term will be settled by mutual agreement of the Parties.

ARTICLE VIII - FINAL PROVISIONS

A. This Agreement will enter into force upon signature, and will remain in force for a period of five years. All information protected by the provisions of this Agreement as proprietary, confidential, privileged, or otherwise subject to restriction on disclosure will remain so protected indefinitely, unless mutually agreed otherwise in writing.

B. Either Party may withdraw from the present Agreement after providing the other Party written notice at least 180 days prior to its intended date of withdrawal. The Party not withdrawing will reserve the right to determine if the withdrawal will result in the other Party receiving a disproportionate share of the expected benefit from this Agreement. If so, both Parties will endeavor to reach an equitable settlement of the matter through negotiation.

C. This Agreement may be amended by written agreement of the Parties.

D. The USNRC and the HAEA recognize the benefits of international cooperation and will endeavor to obtain a mutually agreeable continuation of this Agreement before its expiration.

IN WITNESS WHEREOF, the Parties have signed the present Agreement.

FOR THE UNITED STATES NUCLEAR REGULATORY COMMISSION:

BY: William Travers

NAME: William D. Travers

TITLE: Executive Director for Operations

DATE: 12 MAY 2004

PLACE: Rockville, Maryland

FOR THE HUNGARIAN ATOMIC ENERGY AUTHORITY:

BY:

NAME: Dr. Ivan Lux

TITLE: Deputy Director General Head of the Nuclear Safety Directorate

DATE: 28 May 2004

PLACE: Budapest, Hungary

APPENDIX

PROBABILISTIC RISK ASSESSMENT PROGRAM ELEMENTS

Part I. NRC RESEARCH PROGRAMS IN PROBABILISTIC RISK ASSESSMENT

The international cooperative research effort in probabilistic risk assessment (PRA) has been divided into four general areas of research: (1) Methods Development, (2) Analysis of Operating Events, (3) Development of Advanced PC-Based PRA Software, and (4) Regulatory Applications of PRA. The activities planned in each of these areas are broadly described in the following sections.

1. Methods Development

It is generally recognized that the broad application of PRA to support regulatory decision-making requires methods improvements in a number of risk-significant areas. Among the areas needing improvement are treatment of fire risk, equipment aging, human reliability, and digital systems reliability and risk. NRC programs in these areas are as follows:

a. Fire Risk

The overall purpose of the fire risk research program is to provide technical information in support of the NRC's Risk-Informed Regulation Implementation Plan (RIRIP). In particular, the program will develop fire PRA methods, tools, data, results, and insights needed by the agency to perform risk-informed decision making.

The fire risk program includes activities that 1) improve qualitative and quantitative understanding of the risk contribution due to fires in operating nuclear power plants (NPPs) and other facilities regulated by the NRC; 2) support ongoing or anticipated fire protection activities in the NRC program offices, including the development of risk-informed, performance-based approaches to fire protection for operating NPPs; and 3) evaluate current fire PRA methods and tools and develop improved tools (as needed to support the preceding objectives).

Previous work has led to the development of improved methods, tools, and data in a number of areas, including circuit analysis, fire detection and suppression analysis, and uncertainty analysis; and to the development of fire PRA insights from reviews of past significant fire events. Ongoing work includes efforts to develop comprehensive, state-of-the-art guidance for the conduct of fire PRA (and gain insights from plant-specific application; develop (in cooperation with a number of international organizations) an improved understanding of the uncertainties and limitations in current fire models; support ongoing fire-related regulatory efforts (e.g., the NRC's fire protection Significance Determination Process and associated circuits inspections); and support development of the American Nuclear Society full power fire risk standard.

b. Equipment Aging

The objective of this research effort is to assess the feasibility of using reliability-based physics models to incorporate the effects of aging into an integrated probabilistic risk assessment. Earlier work in this area assessed the feasibility of using this technique for the aging of piping. This work was published in NUREG/CR-5632 in the year 2001. Additional work in this area is the application of this technique to assessing the effect of aging on the failure of in-containment instrumentation and control cables during a loss of coolant accident. A report will be published in 2004 describing a method of assessing the probability of failure of these cables as a function of their age, and the inservice dose rate and temperature the cables are exposed to, with some numerical examples. Additional work will be dependent on obtaining the cooperation of a licensee to provide data on cable insulation materials and the environment of cables.

c. Human Reliability

The general objectives of the human reliability analysis (HRA) research are to: 1) develop improved human reliability analysis (HRA) methods, tools (including guidance), and data needed to support NRC regulatory activities, including the broad implementation of risk-informed regulation; and 2) develop HRA insights to support the development of technical bases for addressing identified or potential safety issues.

Previous work has led to the development of ATHEANA, an improved method for HRA that focuses on the identification of error forcing contexts that increase the likelihood of human errors; the application of ATHEANA in the assessment of pressurized thermal shock (PTS) risk in support of efforts to re-examine the technical basis for 10 CFR 50.61, the PTS rule; and the development of an improved method for HRA quantification that explicitly treats uncertainties. Current work includes the continual use of ATHEANA in PRA applications (e.g., the fire requantification and steam generator tube rupture) the development of an improved method for HRA quantification that includes the use of evidence from a variety of sources; the development of a repository for human event reliability analysis (HERA), and the development of HRA guidance, i.e., an HRA Good Practices document, to support the use of the American Society of Mechanical Engineers (ASME) PRA standard.

d. Digital Systems Reliability and Risk

The increased use of digital instrumentation and control systems in nuclear power plants is introducing some unique reliability and risk issues. This project will be focused on providing methods for more quantitative, probabilistic assessments of digital systems reliability and their impact on overall plant risk, including hardware and software reliability and human-system interface issues. The staff is currently focusing on Failure Mode and Effect Analysis (FMEA) in support of developing reliability models of digital systems. The potential goals are finding a better definition of the reliability problems of digital systems and a better process of applying FMEA to digital systems. The future work is expected to be in the areas of software reliability and the failure rate data development.

2. Analysis of Operating Events

a. ASP Program

The Accident Sequence Precursor (ASP) Program was established by the NRC in 1979 in response to the Risk Assessment Review Group report (see NUREG/CR-0400, September 1978). The primary objective of the ASP Program is to systematically evaluate U.S. nuclear plant operating experience to identify, document, and rank operating events most likely to lead to inadequate core cooling and severe core damage (precursors), if additional failures had occurred.

The other objectives of the ASP Program are:

- To categorize the precursors by their plant-specific and generic implications,
- To support performance measures contained in the Agency's annual Performance and Accountability Report to Congress,
- To provide a measure for trending nuclear plant core damage risk, and
- To provide a partial check on probabilistic risk assessment (PRA)-predicted dominant core damage scenarios.

Events and conditions from licensee event reports, inspection reports, and special requests from NRC staff are reviewed for potential precursors. These potential precursors are analyzed, and a conditional core damage probability (CCDP) is calculated by mapping failures observed during the event onto accident sequences in risk models. An event with a CCDP or a condition with a change in core damage probability greater than or equal to 1×10^{-6} is considered a precursor in the ASP Program.

Plant-specific and generic insights and lessons learned from the ASP program, and other issues of interest that were encountered during the precursor analysis of operating experience (e.g., projection of unanticipated accident scenarios, risk exposure from precursors, and adequacy/availability of risk mitigation measures) are currently being exchanged in annual meetings with OECD countries.

b. SPAR Model Development Program

The Standardized Plant Analysis Risk (SPAR) models are the analysis tool used by staff analysts in many regulatory activities, including the ASP Program. The current set of SPAR models includes PRA models for internal initiating events during full power operation for each operating plant in the U.S. In addition, generic models for low-power and shutdown operations, and Level 2/large early release frequency (LERF) analysis are being developed for several plant categories. Currently, plant specific SPAR models are available only to NRC and licensees.

c. Reactor Performance Data Collection Program and Industry Trends Program

The objectives of these programs are to:

- Collect industry data and produce industry trends for initiating events, common-cause failures, system and component reliabilities, and fire events.
- Establish thresholds for the associated industry trends.
- Develop integrated industry indicators and thresholds for the above.
- Produce parameter estimates for use in the SPAR models and other risk analyses for initiating events, components, and common-cause failures.

The NRC is currently developing a new approach for industry trends. The proposed Baseline Risk Indicator for Initiating Events (BRIIE) uses industry data available from current NRC programs, and is closely tied to risk, e.g., core damage frequency. The BRIIE uses a risk-significant subset of initiating events along with appropriate risk weights obtained from the various plant PRAs.

d. Development of Risk Based Performance Indicators

The NRC is developing a mitigating systems performance index (MSPI) to monitor the performance of six systems based on their ability to perform risk-significant functions. The index comprises two elements - system unavailability and system reliability. Plant-specific PRA models are used to calculate the contribution of component failures and maintenance unavailability to the index, which approximates the change in core damage frequency. The NRC is currently evaluating several technical issues arising from the pilot plant program and is also investigating the feasibility of implementing the MSPI as part of the Agency's Reactor Oversight Process.

3. Development of PC-Based PRA Software

The NRC has developed and maintains the SAPHIRE (Systems Analysis Programs for Hands-on Analysis Integrated Reliability Evaluations) PRA computer code. SAPHIRE offers a state-of-the-art capability for assessing the risk associated with any complex system or facility. In particular SAPHIRE can be used to assess the risk associated with nuclear power plants in terms of core damage frequency (Level 1 PRA) and containment performance and radioactive releases (Level 2 PRA). SAPHIRE includes GEM, a separate subroutine that provides a simplified user interface for performing analysis using SPAR models, discussed above.

Both the continual advancement of the state-of-the-art in the use of computers and the continual expansion of the use of risk-information in the NRC's decision-making, necessitate continual maintenance and improvement of SAPHIRE.

It is expected that this program will continue to provide software maintenance and user support and expand SAPHIRE capabilities by: decreasing size limitations (on the number of basic events, fault trees, sequences, end states, etc. handled by SAPHIRE), speeding up cutset generation and data analysis using multiple processors, adding work group project integration capability, and creating a web-page type user interface with the goal of reducing complexity without losing SAPHIRE's functionality. Furthermore, SAPHIRE's documentation will be revised by issuing a new report for the Windows Versions 6 and 7. Finally, a SAPHIRE interface is being developed to be used in the Reactor Oversight Process.

4. Regulatory Applications of PRA

   a. Changes to Reactor Regulations

   NRC has been actively pursuing the increased use of PRA methods, models, and insights to support regulatory decisions. Among the active programs are those which use PRA results to identify changes needed in reactor safety requirements. There are currently two regulations 10 CFR 50.44 "Standards for Combustible Gas Control Systems in Light-Water-Cooled Power Plants" and 10 CFR 50.46 "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water-Cooled Power Plants" that the staff is revising based on current risk information and research results. In September 2003, NRC concluded rulemaking on 50.44 by issuing risk-informed revision to 50.44 which among other changes, eliminated the current requirements for hydrogen recombiners. Proposals are under consideration for risk-informing 50.46.

   b. Regulatory Guidance on PRA

   The NRC staff has developed a draft regulatory guide (RG) that provides guidance to licensees on how to use PRA standards and industry peer review programs to demonstrate that the risk input to a risk-informed decision is technically defensible. This new RG will be accompanied by a Standard Review Plan (SRP) chapter. The main body of the RG provides guidance on the use of PRA standards and industry guidance by licensees to determine the level of confidence that can be afforded PSA insights/results in support of decision-making. The staff's endorsement of the standards and industry program will be the appendices to this RG. Specifically, Appendices A and B include the staff's position on the American Society of Mechanical Engineers (ASME) PRA standard and the Nuclear Energy Institute (NEI) peer review process respectively both addressing full-power, internal events, excluding internal fire, Level 1 and limited Level 2 (LERF) PRA. As the American Nuclear Society (ANS) PRA standards are issued on external hazards, low power and shutdown and internal fires, additional appendices will be added to the regulatory guide.

   The draft RG was issued in November 2002 for public review and comment. A RG for trial use will be issued for pilot applications in early 2004. Pilot applications include different allowed outage time (AOT) for technical specifications changes and 10CFR 50.69.

   c. Risk of Dry Cask Fuel Storage

   NRC is performing a pilot PSA of a spent fuel dry cask storage system, the Holtec International HI-STORM 100. This cask is being studied at a specific BWR site where the operations can be observed and modeled. (Although developed for a specific cask at a specific site, the analytical models developed for this preliminary study can be modified and applied to other dry cask systems at other reactor sites.) During its service life, the cask has three operational modes - handling in the reactor building, transfer to the storage pad, and storage for 20 years. In each of these modes, accidents that could result in mechanical and thermal challenges to the cask and that have the potential to cause the release of radioactive material, are postulated. Available data are used to estimate accident frequencies. Engineering analyses are used to determine the stresses that would be imposed by the postulated events. The postulated events include drop accidents during handling in the reactor building and transfer to the storage pad. During the storage phase of 20 years on the storage pad, the postulated events include, but are not limited to, tornadoes, tornado generated missiles, earthquakes, floods, meteorites, and gas line explosions. Fracture mechanics and other engineering disciplines are used to determine the probability of a cask failing when subjected to postulated accident conditions.

The preliminary results of the PSA suggest that the risk to the public of the HI-STORM cask at the BWR plant is very low compared to the risk of accidents involving the core of operating nuclear power plants. Accidents and hazards caused by natural phenomena like seismic, high winds, floods, etc., that have a high conditional probability of failing the cask have a very low frequency. Furthermore, the consequences of the postulated accidents that can fracture the cask and the fuel are low because the energy driving the radionuclides from the fuel pellets is low and the inventory of radionuclides in the fuel pellets is relatively low compared to the reactor inventory. Accordingly, the risk, defined as the sum of the products of the accident frequencies and consequences, is very low.

d. Development of Risk Guidelines for Nuclear Materials and Waste Applications

The NRC Commissioners have approved the staff's plans to continue advancements in risk-informing activities in the nuclear materials and waste arenas as a means of improving the Agency's focus on safety, effectiveness, and efficiency, and in reducing unnecessary regulatory burden. As work is completed in the risk informing activities in the nuclear materials and waste arenas, the information will be shared.

APPENDIX

PROBABILISTIC RISK ASSESSMENT PROGRAM ELEMENTS

Part II. HAEA RESEARCH PROGRAMS IN PROBABILISTIC RISK ASSESSMENT

The international cooperative research effort in PRA has been divided into four general areas of research: (1) Methods Development, (2) Analysis of Operating vents, (3) Development of Advanced PC-Based PRA Software, and (4) Regulatory applications of PRA. The activities planned in each of these areas are broadly described in the following sections.

1. Methods Development

It is generally recognized that the broad application of PRA to support regulatory decision-making requires methods developments and improvements in a number of risk-significant areas. Among the areas needing development and improvement are human reliability, risk-based safety performance indicators and modeling aging of equipment. HAEA programs in these areas are as follows:

a. Human Reliability Analysis

HAEA supported previous efforts on developing methods for quantitative human reliability analysis that could explicitly model and quantify the relationship between major influences on human performance and the likelihood of human errors. Numerous special purpose observations were made on a full-scale replica plant simulator to yield qualitative insights and quantitative data in support of HRA method developments. Results of simulator tests and expert opinion were used in a structured manner to develop a decision tree based approach to quantitative HRA.

The objective of further research is to improve current understanding of how situational characteristics (contexts) influence human reliability and use this improved understanding for developing further the existing decision tree based approach. Much attention is paid on transition from the earlier event based to the newly developed symptom based emergency operating procedures and to the associated changes in mental behavior and operation of a control room crew. Simulator studies will be performed by making use of the previous experiments but in a re-designed experimental setting.

The other area of interest in HRA related research is human behavior in mentally challenging situations with multiple equipment failures. Area events such as fires can lead to complex scenarios in which the formulation of the correct response is very difficult due to concurrent failure events and I&C failures in particular. Previous work in this area has led to the development of tools that can be usefully applied to adequately describe such complex scenarios (i.e., loss of controls and indications in the control room from fire induced circuit failures). Methods are still to be developed to help model human behavior and performance in such conditions.

b. Development and Use of Risk-Based Safety Performance Indicators

The application of the PRA models and results was started practically when the first comprehensive level 1 PRA model had been developed. One of the very first applications was the use of PRA for precursor event analysis. The approach applied by the US NRC in the ASP Program was chosen as a basis for the precursor event analysis scheme. As a potential extension to the ASP Program a conceptual framework has been built up for a more comprehensive evaluation of the evens using risk-based safety performance indicators. Several risk-based indicators have been defined and analyzed. At that time their selection was not yet aimed at the identification of a comprehensive set of indicators; it was concerned mainly with unavailability indicators. Analysis of these indicators was performed by simulation of failure events.

The indicator analysis methodology thus underwent a (trial) application and is considered reasonably well developed. Further developments are to be focused on the identification of a comprehensive set of potential risk-based (and maybe not only risk-based) safety performance indicators that may give early signals of negative trends in performance. The potential indicators can be analyzed by the methodology that has been developed and the optimal set of indicators can be defined if appropriate criteria exist. Definition of such criteria is also an area that needs further development.

c. Modeling Aging Effects in PRA

In principle, PRA can be a very useful tool in monitoring the safety level of NPPs throughout their lifetime and initiate remedial actions if necessary. For this purpose, the effects of aging in equipment should be incorporated into the PRA model. To date, no validated methods and data exist for a quantitative expression of aging in the equipment reliability models used in PRA. The research needs of modeling aging effects in PRA should be identified first by reviewing equipment categories and the associated aging related degradation mechanisms that should be looked at for the purpose of aging dependent risk assessment. Available methods and date are to be reviewed and the necessary developments should be identified to establish a consolidated R&D program for PRA with aging equipment. In the longer term, this program should result in a quantitative and dynamic expression of aging in PRA models and results.

2. Analysis of Operating Events

a. PEA Program

Originally the ASP Program was established by the NRC. Following the primary and other objectives of the NRC's ASP Program, the HAEA initiated a Precursor Event Analysis Program. In order to improve its event investigation related activities the HAEA supported the development of a PRA based tool, called Precursor Event Analyzer System (PEAS).

Since a trial period from 1997 to 1999, all operational events occurred at the Paks NPP have been analyzed systematically year by year for potential precursors. The conditional core damage probability (CCDP) is calculated by mapping failures observed during the event onto accident sequences in risk models. The same criteria as in the NRC's ASP Program are accepted by the HAEA to consider an event a precursor.

Plant-specific and generic insights and lessons learned from the HAEA's PEA Program, and other issues of interest that were encountered during the precursor analysis of operating experience (e.g., projection of unanticipated accident scenarios, risk exposure from precursors, and adequacy/availability of risk mitigation measures) are currently being exchanged in annual meetings with OECD countries.

b. Risk Management

The Technical Specifications of the Paks NPP were elaborated following the deterministic requirements in place in the Hungarian nuclear safety regulation. The rigid system of operational limits and conditions was criticized several times by the licensee asking for a reduction of the undue burden posed in the Technical Specifications of the Paks NPP. The HAEA recognized that using insights from PRA can lead to closure of a licensee's initiatives; therefore, it supported the development of a PRA based tool called the Risk Supervisor System (RSS).

The RSS was developed to analyze the effect of certain operational interactions on the core damage frequency as a function of time. The scope of interactions covers equipment/train switch-overs from operational to stand-by mode as well as unexpected outages. It helps the regulatory staff to analyze and better understand the safety implications of an event occurring during the full power operation of a unit and to make decisions on accepting a licensee's request on an exemption related to managing the risk-increase. The planned risk profile of an annual campaign period as well as the actual follow-up risk profile can also be calculated during the plant safety supervision. The RSS system has been applied for all the four units of the plant. Since a trial period from 1977 to 1999, all operational events which occurred at the Paks NPP have been analyzed systematically year by year by the RSS. Plant-specific and generic insights and lessons learned from the analyses are taken into consideration when evaluating the safety performance of the licensee.

3. Development of PC-Based PRA Software

Recent work in this area included the development of computerized tools to support the use or risk information at HAEA. These tools are:

- a risk supervisor that is in regular use to evaluate the risk of equipment-out-or-service configurations and generate risk profiles for longer periods of operation by taking into account changes in systems configuration and equipment unavailability,
- a precursor event analysis system that is customized to help a PRA based analysis of operational events similarly to the ASP program of the NRC but with the use of plant specific PRA models,

- a severe accident precursor system that is installed at the Center for Emergency Response, Training and Analysis of HAEA to help assess the likelihood of a severe accident in case of an emergency.

To date, all the software are capable of risk assessment using level 1 PRA models for internal events at full power operation. Future extensions and improvements will include the consideration of internal fires and flooding as well as internal events in low power and shutdown states. These are considered a substantial advancement because they will enable a more comprehensive risk assessment (e.g., operational events during shutdown operations will be simpler to evaluate) and will provide valuable additional capabilities (e.g., risk based evaluation of a maintenance program for plant outages). The technical contents of these planned developments include the development and incorporation of the necessary plant specific PRA models into the above risk analysis tools, and improvement of the software in order to communicate with the new PRA models and to provide for the extended software functions.

4. Regulatory Applications of PRA

a. Categorization of NPP Equipment by Safety Significance

Safety classification of equipment at the Paks NPP is based on a system of purely deterministic rules stated in the Hungarian nuclear safety regulation. This classification reflects the safety importance of the equipment, but not their safety significance. A preliminary study from 1999 revealed inconsistency between the classification of equipment based on deterministic rules and the categorization of the equipment based on their safety significance characterized by PRA indicators. Accordingly, equipment was highly ranked by PRA, but classified to a relatively low safety class by deterministic rules and on the opposite side, equipment in a higher safety class was defined as having relatively low safety significance. In its systematic approach to risk-informed regulation the HAEA initiated an R&D project to categorize NPP equipment y their safety significance.

The objective of the R&D project is to define applicable indicators characterizing the safety significance of the NPP equipment considering full and low power and shutdown states, internal and external initiators of both level 1 and 2 PRA. Having the indicators defined, the other objective of the project is to perform the categorization of the equipment. The final objective of the project is to feed back the results and experiences into the daily regulatory activities of HAEA.

b. Probabilistic Safety Criteria

The safety philosophy of nuclear installations and consequently the principles of the regulatory decision making contain both deterministic and probabilistic considerations. Performing the PRA modeling for the Paks NPP in an ever widening scope the basic knowledge in PRA techniques has been enlarged, which can e applied for risk-informing the decision making process of the regulatory authority. For the realization of the risk-informed decision making many further conditions have to be met and availability of a set of probabilistic safety criteria (PSC) is one important condition among them. An R&D project has been initiated recently by the

HAEA for elaboration of PSC to be considered in the different areas of the regulatory activities and to develop PRA based tools to support the analysis in concrete regulatory issues whether PSC are met.

c. Regulatory Requirements and Guidance for PRA Quality

The HAEA initiated an R&D project to define regulatory requirements and to elaborate guidance on PRA quality. The objective is to contribute by these means to the increasing of the quality of PRA models and tools already available and being prepared in the future and to fostering the application of PRA by the licensee. The requirements and the guidance take into consideration the state-of-the-art international experiences and the country specific circumstances.

INTELLECTUAL PROPERTY ADDENDUM

Pursuant to Article V of this Agreement:

The Parties shall ensure adequate and effective protection of intellectual property created or furnished under this Agreement and relevant implementing arrangements. The Parties agree to notify one another in a timely fashion of any inventions or copyrighted works arising under this Agreement and to seek protection for such intellectual property in a timely fashion. Rights to such intellectual property shall be allocated as provided in this Addendum.

I. SCOPE

1. This Addendum is applicable to all cooperative activities undertaken pursuant to this Agreement, except as otherwise specifically agreed by the Parties or their designees.

2. For purposes of this Agreement, "intellectual property" shall have the meaning found in Article 2 of the Convention Establishing the World Intellectual Property Organization, done at Stockholm, July 14, 1967; viz., "'intellectual property' shall include the rights relating to:

   - literary, artistic and scientific works,
   - performances of artists, phonograms, and broadcasts,
   - inventions in all fields of human endeavor,
   - scientific discoveries,
   - industrial designs,
   - trademarks, service marks, and commercial names and designations,
   - protection against unfair competition, and all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields."

3. This Addendum addresses the allocation of rights, interests, and royalties between the Parties. Each party shall ensure that the other Party can obtain rights to intellectual property allocated in accordance with the Addendum by obtaining those rights from its own participants through contracts or other legal means, if necessary. This Addendum does not otherwise alter or prejudice the allocation between a Party and its nationals, which shall be determined by that Party's laws and practices.

4. Disputes concerning intellectual property arising under this Agreement should be resolved through discussions between the concerned participating institutions or, if necessary, the Parties or their designees. Upon mutual agreement of the Parties, a dispute shall be submitted to an arbitral tribunal for binding arbitration in accordance with the applicable rules of international law. Unless the Parties or their designees agree otherwise in writing, the arbitration rules of the United Nations Commission on International Trade Law (UNCITRAL) shall govern.

5. Termination or expiration of this Agreement shall not affect rights or obligations under this Addendum.

II. ALLOCATION OF RIGHTS

1. Each Party shall be entitled to a non-exclusive, irrevocable, royalty-free license in all countries to translate, reproduce, and publicly distribute scientific and technical journal articles, reports, and books directly arising from cooperation under this Agreement. All publicly distributed copies of copyrighted work prepared under this provision shall indicate the names of the authors of the work unless an author explicitly declines to be named.

2. Rights to all forms of intellectual property, other than those rights described in Section II.1., above, shall be allocated as follows:

   a. Visiting researchers, for example, scientists visiting primarily in furtherance of their education, shall receive intellectual property rights under the policies of the host institution. In addition, each visiting researcher named as an inventor shall be entitled to share in a portion of any royalties earned by the host institution from the licensing of such intellectual property.

   b. (1) For intellectual property created during joint research, for example, when the Parties, participating institutions, or participating personnel have agreed in advance on the scope of work, each Party shall be entitled to obtain all rights and interests in its own country. The Party in whose country the invention was made shall have first option to acquire all rights and interests in third countries. If research is not designated as "joint research", rights to intellectual property arising from the research will be allocated in accordance with paragraph II.2.a. In addition, each person named as an inventor shall be entitled to share in a portion of any royalties earned by either institution from the licensing of the property.

   (2) Notwithstanding paragraph II.2.b.(1), if a type of intellectual property is available under the laws of one Party but not the other Party, the Party whose laws provide for this type of protection shall be entitled to all rights and interests worldwide. Persons named as inventors of the property shall nonetheless be entitled to royalties as provided in paragraph II.2.b.(1).